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PATENT ABSTRACTS OF JAPAN

(11)Publication number : **08-250923**

(43)Date of publication of application : **27.09.1996**

(51)Int.CI. **H01Q 3/40**

(21)Application number : **07-050228**

(22)Date of filing : **09.03.1995**

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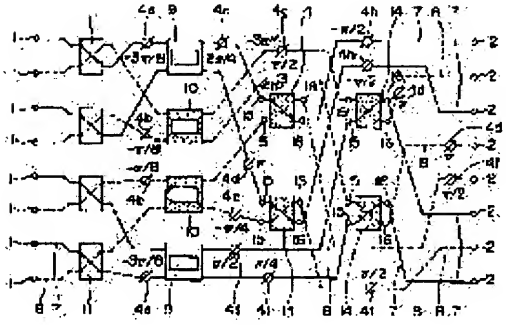
54) BATLER MATRIX CIRCUIT AND FEEDING METHOD BY THE CIRCUIT

(57)Abstract:

PURPOSE: To attain the circuit in which the operation characteristic is excellent and a manufacturing cost is low because no crossing of microstrip lines is caused to allow the circuit to have provision even for the case that plural antenna elements are arranged on the same plane.

CONSTITUTION: High frequency signals inputted from input terminals 1, 1,... formed on a surface of 1st and 2nd dielectric bodies are coupled by slot coupling hybrid circuits 11, 11,... electromagnetically. Then two high frequency signals outputted on the same plane among the high frequency signals outputted from the slot coupling hybrid circuits 11, 11,... are coupled by branch line hybrid circuits 9, 9 or 10, 10. After the phases of the high frequency signals outputted from the branch line hybrid circuits 9, 9 or 10, 10 are adjusted and the resulting signals are inputted to coupling hybrid circuits 14, 14,..., from which the signals are outputted while the phases of the two high frequency signals are replaced with each other equivalently.



2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention supplies a RF signal to two or more antenna elements, and relates to the electric supply method by the Butler matrix circuit and this circuit suitable for especially mass production.
[0002]
[Description of the Prior Art] Drawing 6 is the connection diagram showing the 1st example of composition of the antenna feeder circuit using the conventional Butler matrix circuit. In this drawing, 1 and 1 -- is a transmission line according [-- / input terminal, 2, and 2 / -- / output terminal, 3, and 3 / phase-shifter, 5, and 5 --] to a microstrip line in branch line type hybrid circuit, 4, and 4 --, and 6 and 6 -- shows transmission-line 5 comrade's crossing.
[0003]
[Problem(s) to be Solved by the Invention] This drawing shows the branch line type hybrid circuit 3 and 8 port BATORA matrix feeder circuit which used only 3 --. Thus, if only the branch line type hybrid circuit 3 of flat-surface monolayer structure and 3 -- constitute the conventional Butler matrix feeder circuit, a crossing 6 will be generated in each transmission line 5. It had become the factor which needs to constitute an air bridge, a semi rigid cable or VIA (through hole), etc. in this crossing 6, is made to increase a manufacturing process to it, and makes cost high. Moreover, the influence which a manufacture error has on an operating characteristic was also large, and the trouble that an operating characteristic became unstable simultaneously with one with it difficult [to acquire the target property] had it.
[0004] On the other hand, drawing 7 is the connection diagram showing the 2nd example of composition of the antenna feeder circuit using the conventional Butler matrix circuit. This view is the example in which the antenna feeder circuit by the Butler matrix circuit was formed, as each side of the circuit board (all are illustration abbreviation) which consists of dielectrics of two sheets which sandwich a grand board (cope plate) is straddled. In addition, this view explains this side as the upper surface. It is a transmission line [according / on drawing 7 and / an output terminal and 4 / to a microstrip line in 1 and 1 --] according [input terminal, 2, and 2 --] in phase-shifter, 7, and 7 -- and 8, and 8 -- to four, and a transmission line 7 and 7 -- are formed in the upper surface of the circuit board, and a transmission line 8 and 8 -- are formed in the inferior surface of tongue.
[0005] Moreover, the branch line type hybrid circuit by which 9 was formed in the upper surface of the circuit board, and 10 are the branch line type hybrid circuits formed in the inferior surface of tongue. the slot (aperture) by which 11 and 11 were formed in the grand board -- minding -- a transmission line 7 and a transmission line 8 -- electromagnetism -- it is a slot coupling type hybrid circuit for making it join together-like
[0006] 4 port BATORA matrix circuit consists of these views, without producing

intersection of a transmission line by combining the slot coupling type hybrid which combines each field of a branch line type hybrid circuit and the circuit board formed in each side of the circuit board. However, when 8 port BATORA matrix circuit is constituted combining the slot coupling type hybrid which combines each field of a branch line type hybrid circuit and the circuit board formed in each field of the circuit board like this composition, the intersection produced in each transmission line cannot be escaped. Moreover, although between the circuit board and antenna elements will be connected with a coaxial cable etc. in this case, when two or more antenna elements were arranged by the coplanar, there was a trouble that it could not respond.

[0007] Furthermore, drawing 8 is the connection diagram having shown the example of composition of 8 port BATORA matrix circuit constituted by combining the slot coupling type hybrid circuit formed in the circuit board as mentioned above. In this drawing, transmission-line [by which output terminal, 7 and 7 -- was formed / 11 and 11 -- / slot coupling type hybrid circuit, 12, and 12 -- / in the upper surface for input terminal, 13, and 13 -- on the upper surface of the circuit board], 8, and 8 -- is the transmission line formed in the inferior surface of tongue.

[0008] In the Butler matrix circuit of composition of being shown in drawing 8 , they are each output terminals 13 and 13. -- The alignment phase shift relation of a between is not maintained. Therefore, although between the circuit board and antenna elements will be connected with a coaxial cable etc. also in this case, when two or more antenna elements are arranged by the coplanar, it cannot respond. Since it was not made under the above backgrounds and intersection of a microstrip line does not arise, an operating characteristic is good and a manufacturing cost's is low, and this invention aims at offering the electric supply method by the Butler matrix circuit and this circuit which can respond when further two or more antenna elements are arranged by the coplanar.

[0009]

[Means for Solving the Problem] If it is in invention according to claim 1 in order to solve the technical problem mentioned above In 8 port BATORA matrix circuit which consists of double-sided substrates which minded [of the grand board] the dielectric to the 1st hybrid circuit of an input side The hybrid circuit combined-like is used. the slot formed in the aforementioned grand board -- the field where the aforementioned double-sided substrate is mutual -- electromagnetism -- In the 2nd hybrid circuit connected to each of two output terminals of the 1st hybrid circuit To the 3rd hybrid circuit connected to each of two output terminals of the 2nd hybrid circuit, using the hybrid circuit formed in whole surface composition The hybrid circuit combined-like is used. the slot formed in the aforementioned grand board -- the field where the aforementioned double-sided substrate is mutual -- electromagnetism -- It is characterized by connecting to at least one a phase adjustment means to replace the phase relation of a RF signal in equivalent among each terminal which the 3rd hybrid circuit has.

[0010] moreover -- if it is in invention according to claim 2 -- a conductor -- with the grand board which consists of boards It is the Butler matrix circuit which consists of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or the 2nd dielectric board. The 1st input terminal group formed in the dielectric body surface of the above 1st, and the 2nd input terminal group formed in the dielectric body surface of the above 2nd, the RF signal inputted from the input terminal group of the RF

signal and the above 2nd which were inputted from the input terminal group of the above 1st -- electromagnetism -- with the 1st coupled-circuit group combined-like The 2nd coupled-circuit group which combines the RF signal which it is formed in each of the front face of the 1st dielectric of the above, and the front face of the 2nd dielectric of the above, and two coupled circuits of the coupled-circuit group of the above 1st in the same flat surface output, The 3rd coupled-circuit group combined-like is provided. the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 1st outputs, and the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 2nd outputs -- electromagnetism -- Each coupled circuit which constitutes the above 1st and the 3rd coupled-circuit group is characterized by consisting of a slot formed in the aforementioned grand board, and a microstrip line formed in the position which corresponds with the aforementioned slot in each front face of the above 1st and the 2nd dielectric.

[0011] If it is in invention according to claim 3, moreover, in the Butler matrix circuit according to claim 2 In two input terminals which each coupled circuit which constitutes the coupled-circuit group of the above 3rd has The microstrip line which adjusts the phase of the aforementioned RF signal inputted respectively is connected. It is characterized by connecting to at least one the microstrip line which adjusts the phase of the aforementioned RF signal among each terminal which each coupled circuit which constitutes the coupled-circuit group of the above 3rd has.

[0012] moreover -- if it is in invention according to claim 4 -- a conductor -- with the grand board which consists of boards It is the electric supply method by the Butler matrix circuit which consists of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or the 2nd dielectric board. The slot which inputted the RF signal from the 1st input terminal group formed in the dielectric body surface of the above 1st, and the 2nd input terminal group formed in the dielectric body surface of the above 2nd, and was formed in the aforementioned grand board, In each front face of the above 1st and the 2nd dielectric It is made to join together-like. the RF signal inputted from the input terminal group of the RF signal and the above 2nd which were inputted from the input terminal group of the above 1st by the 1st coupled-circuit group which consists of an aforementioned slot and a microstrip line formed in the corresponding position -- electromagnetism -- By the 2nd coupled-circuit group formed in each of the front face of the 1st dielectric of the above, and the front face of the 2nd dielectric of the above Combine the RF signal which two coupled circuits of the coupled-circuit group of the above 1st in the same flat surface output, and by the coupled-circuit group of the above 1st, and the 3rd coupled-circuit group formed similarly the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 1st outputs, and the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 2nd outputs -- electromagnetism -- it is characterized by making it join together-like and outputting

[0013] Moreover, the RF signal with which the phase was adjusted respectively is inputted into two input terminals which each coupled circuit which constitutes the coupled-circuit group of the above 3rd from an electric supply method by the Butler matrix circuit according to claim 4 has if it is in invention according to claim 5, and it is characterized by outputting the RF signal which adjusted the phase respectively from two

output terminals which each coupled circuit which constitutes the coupled-circuit group of the above 3rd has.
[0014]
[Function] In the Butler matrix circuit which is constituted by the front face of the 1st which sandwiches a grand board, and 2nd dielectric boards by the microstrip line according to this invention The RF signal inputted from the 2nd input terminal group formed in the RF signal and the 2nd dielectric body surface which are inputted from the 1st input terminal group formed in the 1st dielectric body surface the 1st coupled-circuit group which consists of a slot and a microstrip line formed in the corresponding position in each front face of the slot formed in the grand board, the 1st, and 2nd dielectrics -- inputting -- electromagnetism -- it is made to join together-like Two RF signals outputted in the same flat surface among the RF signals which the coupled circuit which constitutes this 1st coupled-circuit group outputs are inputted and combined with the 2nd coupled-circuit group formed in each of the front face of the 1st dielectric, and the front face of the 2nd dielectric. Furthermore, after adjusting the RF signal which the 2nd coupled-circuit group formed in the 1st dielectric body surface outputs, and the RF signal which the 2nd coupled-circuit group formed in the 2nd dielectric body surface outputs in each of the phase, it inputs into the 1st coupled-circuit group and the 3rd same coupled-circuit group, and the phase of these two RF signals is replaced in equivalent, and is outputted.
[0015]
[Example] the following -- ****** -- it ****** just Drawing 1 is the connection diagram showing the composition of one example of this invention. This view is the example in which the antenna feeder circuit by the Butler matrix circuit was formed, as each side of the circuit board (all are illustration abbreviation) which consists of dielectrics of two sheets which sandwich a grand board is straddled. In addition, this view explains this side as the upper surface. drawing 1 -- setting -- 1 and 1 ... an input terminal, and 2 and 2 ... is an output terminal and 4a-4i are phase shifters Phase shifters 4a-4i have the phase contrast which is -3pi/8, -pi / 3pi [8 and]/4pi, -pi/4, pi/2, -3pi/4, -pi/2, and pi/4, respectively (a unit is rad for all). 7 and 7 ..., and 8 and 8 -- the transmission line according [...] to a microstrip line -- it is -- transmission lines 7 and 7 ... is formed in the upper surface of the circuit board -- having -- **** -- transmission lines 8 and 8 ... is formed in the inferior surface of tongue of the circuit board
[0016] 9, 9, and 10 and 10 are branch line type hybrid circuits, and the branch line type hybrids 9 and 9 are formed in the upper surface of the circuit board, and the branch line type hybrid circuits 10 and 10 are formed in the inferior surface of tongue of the circuit board. One side constitutes a closed loop using the strip line or four pieces of microstrip lines of quadrant wavelength, and a branch line type hybrid circuit takes out an input/output terminal from each angle. A RF signal is effectively compounded by very few loss, or it is made to branch by this.
[0017] the slot by which 11 and 11 were formed in the grand board -- minding -- a transmission line 7 and a transmission line 8 -- electromagnetism -- it is a slot coupling type hybrid circuit for making it join together-like In two micro-stripe transmission lines which are originally divided with a grand board, and ** and are parallel, by forming a slot in a grand board in the meantime, a slot coupling type hybrid circuit constitutes a directional coupler (hybrid circuit), and a RF signal is compounded effectively or it branches it by very few loss.

[0018] the slot by which 14 and 14 were formed in the grand board -- minding -- a transmission line 7 and a transmission line 8 -- electromagnetism -- although it is a slot coupling type hybrid circuit for making it join together-like, the detailed composition is shown in drawing 2 As shown in drawing 2 , the slot coupling type hybrid circuit 14 has the slot coupling type hybrid circuit 11 and phase shifters 4d, 4f, and 4h between terminals 15, 15-16 and 16.
[0019] this example -- setting -- input terminals 1 and 1 -- the slot coupling type hybrid circuits 11 and 11 whose RF signals inputted from ... are the 1st hybrid circuit -- it is inputted into ... Moreover, each slot coupling type hybrids 11 and 11 ... The RF signal outputted from each output terminal is inputted into the branch line type hybrids 9 and 9 which are the 2nd hybrid circuit, or 10 and 10.
[0020] furthermore, the slot coupling type hybrid circuits 14 and 14 whose RF signals outputted from each branch line type hybrid circuits 9 and 9 or the output terminal of 10 and 10 are the 3rd hybrid circuit -- it is inputted into ... these slot coupling type hybrids 14 and 14 -- the RF signal outputted from each output terminal of ... each output terminals 2 and 2 -- it is outputted from ... At this time, two output terminals of each slot coupling type hybrid circuit 14 are replaced in [the phase shift] equivalent by 4f of phase shifters, and 4h of phase shifters. therefore, each output terminals 2 and 2 -- from ..., the RF signal with which the phase gathered is outputted
[0021] An example of the concrete circuit pattern of this invention is shown in drawing 3 and the drawing 4 row at drawing 5 . Here, the circuit pattern shown in drawing 3 or drawing 5 shall be a microstrip line formed of copper foil etc., and shall constitute the feeder circuit using 8 port BATORA matrix circuit by this. Moreover, drawing 3 is drawing where drawing 4 looked at the pattern 18-2 of a grand side (ground plane), and drawing 5 looked at the circuit pattern 18-3 of the 2nd page for the circuit pattern 18-1 of the 1st page from the upper surface, respectively. These circuit pattern 18-1, 18-2 and 18-2, and 18-3 are made to rival on both sides of a dielectric board (illustration ellipsis), respectively.
[0022] In drawing 3 , 1-1 to 1-4 is an input terminal. 17-1 to 17-4 [moreover,] -- a slot coupling type hybrid -- it is -- respectively -- the transmission lines 7 and 7 from an input terminal 1-1 to 1-4 -- a RF signal is inputted through ... 9-1 is a branch line type hybrid circuit, and the slot coupling type hybrid 17-1 and the output terminal of 17-2 are connected to each of this input terminal through transmission lines 7 and 7, respectively. Moreover, 9-2 is a branch line type hybrid circuit, and the slot coupling type hybrid 17-3 and the output terminal of 17-4 are connected to each of this input terminal through transmission lines 7 and 7, respectively.
[0023] Each output terminal of the branch line type hybrid circuit 9-1 is connected to the slot coupling type hybrid 17-5 and the input terminal of 17-6 through transmission lines 7 and 7, respectively. Moreover, each output terminal of the branch line type hybrid circuit 9-2 is connected to the slot coupling type hybrid 17-7 and the input terminal of 17-8 through transmission lines 7 and 7, respectively. 2-1 to 2-4 is an output terminal. this output terminal 2-1 to 2-4 -- respectively -- transmission lines 7 and 7 -- the output terminal of the slot coupling type hybrid circuit 17-5 to 17-8 is connected through ...
[0024] In drawing 4 , the slot 19-1 to 19-8 is formed in the circuit pattern 18-2 of a grand side. This slot 19-1 to 19-8 is formed in the slot type hybrid circuit 17-1 to 17-8 and the corresponding position for which the circuit pattern 18-1 of the 1st page is constituted,

respectively. Moreover, the slot type hybrid circuit 20-1 to 20-8 mentioned later is formed in this slot 19-1 to 19-8, and a corresponding position in the circuit pattern 18-3 of the 2nd page, respectively.
[0025] In drawing 5 , 1-5 to 1-8 is an input terminal. 20-1 to 20-4 [moreover,] -- a slot coupling type hybrid -- it is -- respectively -- the transmission lines 8 and 8 from an input terminal 1-5 to 1-8 -- a RF signal is inputted through ... 9-3 is a branch line type hybrid circuit, and the slot coupling type hybrid 20-1 and the output terminal of 20-2 are connected to each of this input terminal through transmission lines 8 and 8, respectively. Moreover, 9-4 is a branch line type hybrid circuit, and the slot coupling type hybrid 20-3 and the output terminal of 20-4 are connected to each of this input terminal through transmission lines 8 and 8, respectively.
[0026] Each output terminal of the branch line type hybrid circuit 9-3 is connected to the slot coupling type hybrid 20-5 and the input terminal of 20-6 through transmission lines 8 and 8, respectively. Moreover, each output terminal of the branch line type hybrid circuit 9-2 is connected to the slot coupling type hybrid 20-7 and the input terminal of 20-8 through transmission lines 7 and 7, respectively. 2-5 to 2-8 is an output terminal. this output terminal 2-5 to 2-8 -- respectively -- transmission lines 8 and 8 -- the output terminal of the slot coupling type hybrid circuit 20-5 to 20-8 is connected through ...
[0027] As mentioned above, the slot type hybrid circuit 20-1 to 20-8 is formed in a slot 19-1 to 19-8, and a corresponding position, respectively. Moreover, the slot 19-1 to 19-8 is formed in the slot type hybrid circuit 17-1 to 17-8, and the corresponding position, respectively. each by which the slot coupling type hybrid 17-1 to 17-8 formed in the circuit pattern 18-1 was formed in the circuit pattern 18-3 of this -- the slot coupling type hybrid 20-1 to 20-8, and electromagnetism -- it has joined together-like
[0028] the transmission lines 7 and 7 which connect each part so that each phase relation of an output terminal 2-1 to 2-8 may become proper in the Butler matrix circuit shown in drawing 3 or drawing 5 ... and transmission lines 8 and 8 -- the length of ... or width of face is determined beforehand
[0029] Thus, 8 port BATORA matrix circuit can be constituted, without producing intersection of a microstrip line by forming the circuit pattern shown in drawing 3 or drawing 5 on both sides of a dielectric. Moreover, since wiring by formation of the through hole for connecting the circuit pattern 18-1 of the 1st page and the circuit pattern 18-3 of the 2nd page in this case, the semi rigid cable, etc. is unnecessary, a manufacturing process is simplified and mass-production-ization is attained.
[0030] In addition, although 8 port BATORA matrix circuit was mentioned as the example and the above-mentioned example explained it, you may be things other than this. Moreover, although the example which used the branch line type hybrid circuit for the coupled circuit in the same flat surface was shown, you may be the coupled circuit (a hybrid circuit, synthetic circuit) formed in the same flat surface.
[0031]
[Effect of the Invention] In the Butler matrix circuit which is constituted by the front face of the 1st which sandwiches a grand board, and 2nd dielectric boards by the microstrip line according to this invention as explained above The RF signal inputted from the 2nd input terminal group formed in the RF signal and the 2nd dielectric body surface which are inputted from the 1st input terminal group formed in the 1st dielectric body surface the 1st coupled-circuit group which consists of a slot and a microstrip line formed in the

corresponding position in each front face of the slot formed in the grand board, the 1st, and 2nd dielectrics -- inputting -- electromagnetism -- it is made to join together-like Two RF signals outputted in the same flat surface among the RF signals which the coupled circuit which constitutes this 1st coupled-circuit group outputs are inputted and combined with the 2nd coupled-circuit group formed in each of the front face of the 1st dielectric, and the front face of the 2nd dielectric. Furthermore, the RF signal which the 2nd coupled-circuit group formed in the 1st dielectric body surface outputs and the RF signal which the 2nd coupled-circuit group formed in the 2nd dielectric body surface outputs Since it inputs into the 1st coupled-circuit group and the 3rd same coupled-circuit group, and the phase of these two RF signals is replaced in equivalent and outputted after adjusting the phase in each Since intersection of a microstrip line does not arise, an operating characteristic is good and a manufacturing cost's is low. The effect that the electric supply method by the Butler matrix circuit and this circuit which can respond when further two or more antenna elements are arranged by the coplanar is realizable is acquired. Moreover, the process of wiring by formation of a through hole or the semi rigid cable becomes unnecessary, and mass-production-ization can be performed effectively.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] In 8 port BATORA matrix circuit which consists of double-sided substrates which minded [of the grand board] the dielectric to the 1st hybrid circuit of an input side The hybrid circuit combined-like is used. the slot formed in the aforementioned grand board -- the field where the aforementioned double-sided substrate is mutual -- electromagnetism -- In the 2nd hybrid circuit connected to each of two output terminals of the 1st hybrid circuit To the 3rd hybrid circuit connected to each of two output terminals of the 2nd hybrid circuit, using the hybrid circuit formed in whole surface composition The hybrid circuit combined-like is used. the slot formed in the aforementioned grand board -- the field where the aforementioned double-sided substrate is mutual -- electromagnetism -- The Butler matrix circuit characterized by connecting a phase adjustment means to change the phase relation of a RF signal to at least one in equivalent among each terminal which the 3rd hybrid circuit has.
[Claim 2] It is the Butler matrix circuit which is equipped with the following and characterized by each coupled circuit which constitutes the above 1st and the 3rd coupled-circuit group consisting of a slot formed in the aforementioned grand board, and a microstrip line formed in the position which corresponds with the aforementioned slot in each front face of the above 1st and the 2nd dielectric. a conductor -- the grand board which consists of boards The 1st and the 2nd dielectric board which sandwich the aforementioned grand board. The 1st input terminal group which is the Butler matrix circuit which consists of microstrip lines constituted from copper foil etc. by the front face of the above 1st or the 2nd dielectric board, and was formed in the dielectric body surface of the above 1st. the RF signal inputted from the input terminal group of the RF signal and the above 2nd which were inputted from the 2nd input terminal group formed in the dielectric body surface of the above 2nd, and the input terminal group of the above 1st -- electromagnetism -- with the 1st coupled-circuit group combined-like The 2nd coupled-circuit group which combines the RF signal which it is formed in each of the front face of the 1st dielectric of the above, and the front face of the 2nd dielectric of the above, and two coupled circuits of the coupled-circuit group of the above 1st in the same flat surface output, the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 1st outputs, and the RF signal which the 2nd coupled-circuit group formed in the dielectric body surface of the above 2nd outputs -- electromagnetism -- the 3rd coupled-circuit group combined-like
[Claim 3] The Butler matrix circuit according to claim 2 characterized by connecting the microstrip line which adjusts the phase of the aforementioned RF signal inputted respectively to two input terminals which each coupled circuit which constitutes the

coupled-circuit group of the above 3rd has, and connecting the microstrip line which adjusts the phase of the aforementioned RF signal to at least one among each terminal which each coupled circuit which constitutes the coupled-circuit group of the above 3rd has.

NOTICES *

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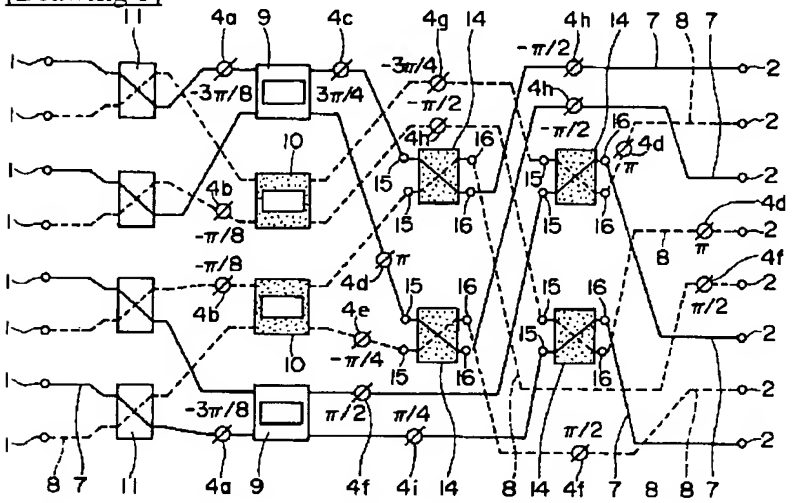
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

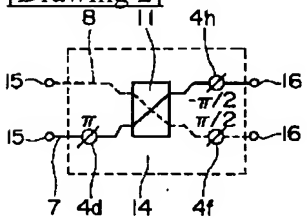
3.In the drawings, any words are not translated.

DRAWINGS

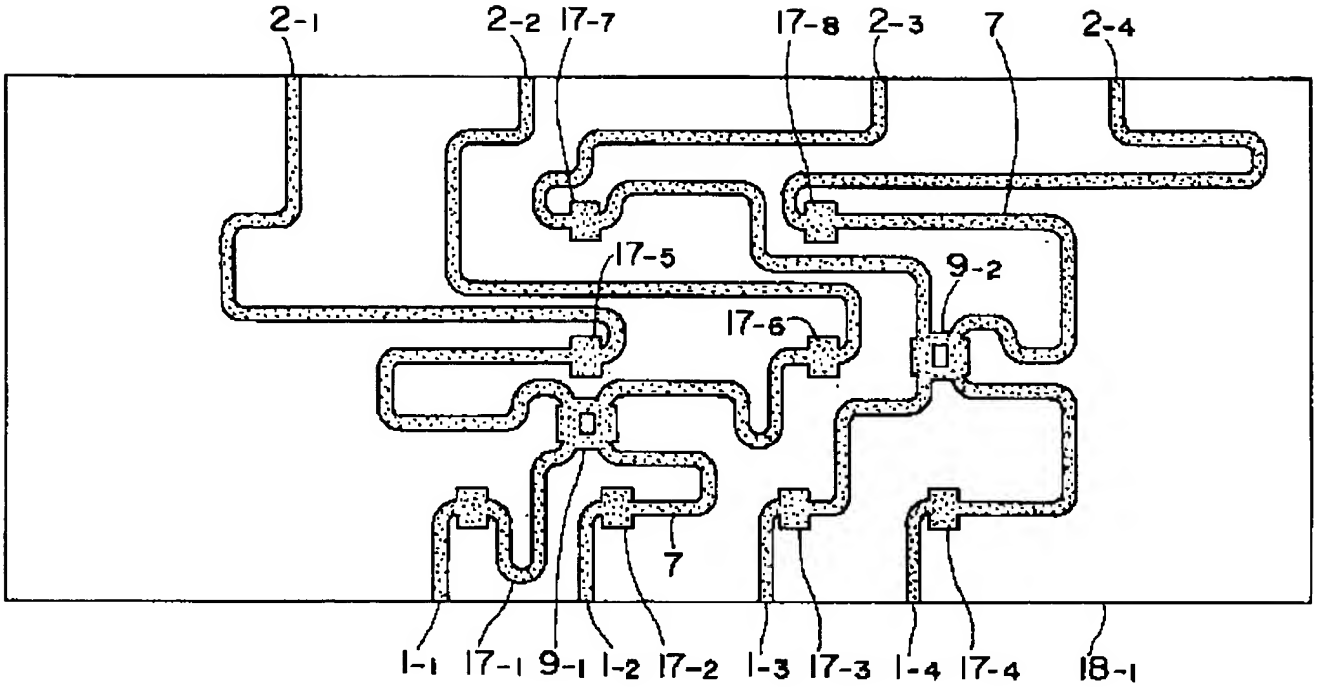
[Drawing 1]



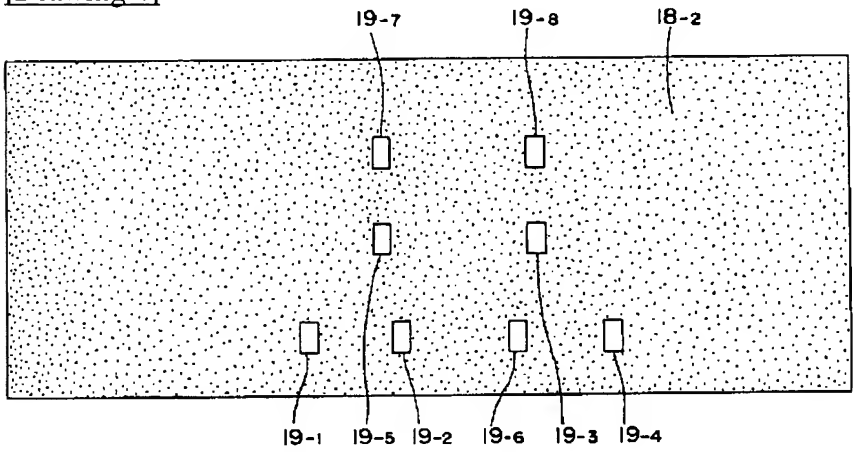
[Drawing 2]



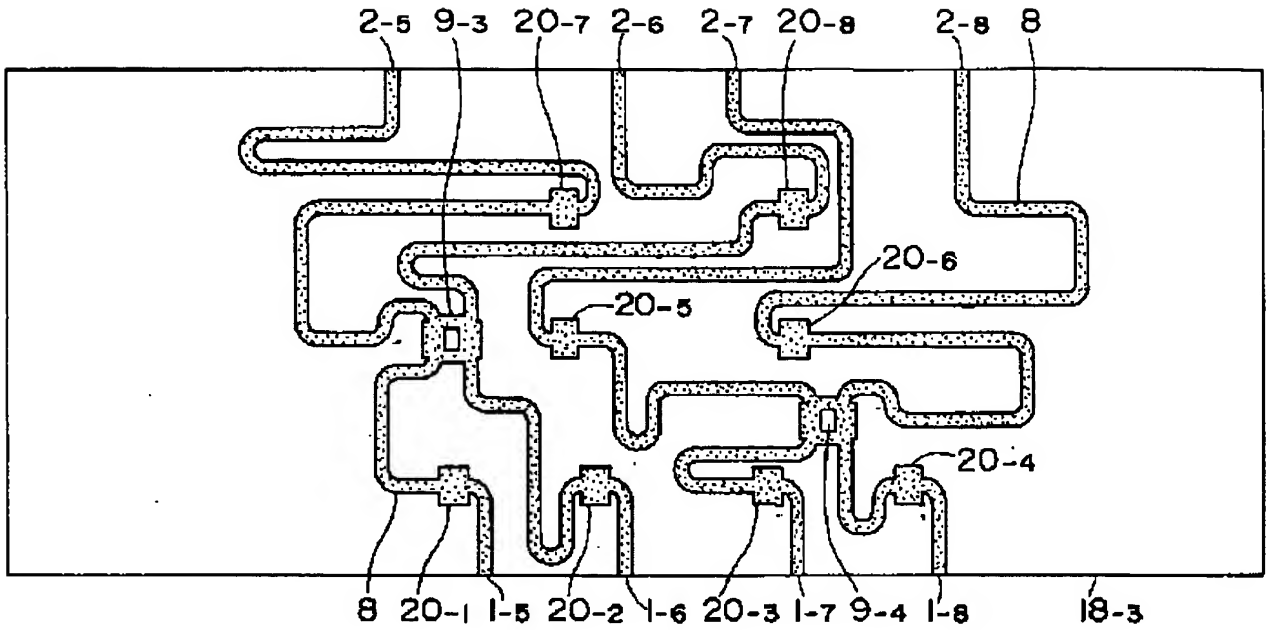
[Drawing 3]



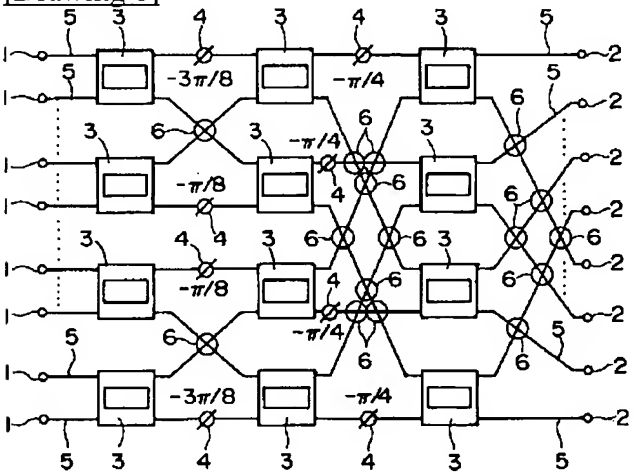
[Drawing 4]



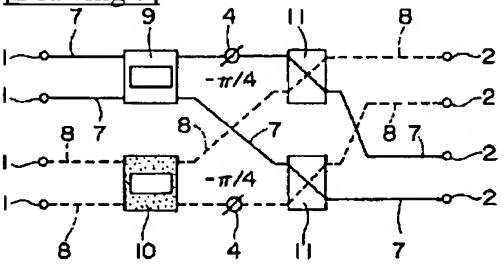
[Drawing 5]



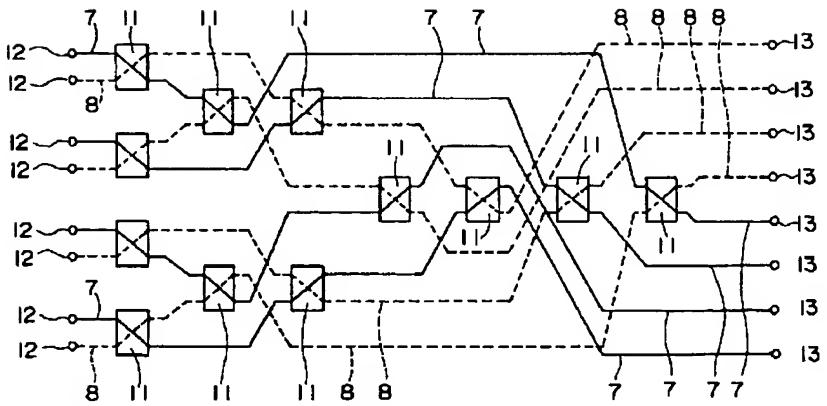
[Drawing 6]



[Drawing 7]



[Drawing 8]



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